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ABSTRACT

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TEMPORAL CONSTRAINTS ON THE PROCESSING OF LINGUISTIC TRANSFORMATIONS IN CONNECTED DISCOURSE

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Abstract

Linguistic models, especially the derivational theory of complexity, partially explain human comprehension of isolated sentences but not connected discourse. Two versions of a message, one entirely active sentences, the other entirely passive were written to compare transformational complexity. Ss heard the messages at normal (150 wpm) rates or compressed rates (250 wpm) to constrain processing time. All 108 Ss, including control Ss who heard no messages, completed cloze tests.

The results failed to support the use of linguistic models to predict comprehension of natural language in connected discourse. Differences in findings of experiments using isolated sentences versus experiments using connected discourse as stimuli are not simply explainable as a function of greater processing time available to Ss hearing connected discourse.

TEMPORAL CONSTRAINTS ON THE PROCESSING OF LINGUISTIC TRANSFORMATIONS IN CONNECTED DISCOURSE

A decade of psycholinguistic research, dominated by the generative-transformational model of language, has established that rule-governed processes described by linguists are often reflected in human psychological performance. One of the most controversial areas of this research centered around the question of the psychological reality of linguistic transformations. That is, are transformational rules, analogous to those described by linguists, actually employed by human beings when processing and comprehending language?

Much of the research has centered around the active and passive transformations in particular simply because these transformations differ only in syntactic form but do not change the referential or denotative meaning of a sentence. The generative-transformational grammar provided by Noam Chomsky (1957, 1966) posits that both active and passive sentences are related to the same deep structure and are generated into their respective surface structures by various elementary transformations. Passive sentences contain two transformations not present in active sentences. That is, a passive sentence involves (1) a reversal of the logical subject and the logical object of the sentence, and (2) the addition of the function words such as "was" and "by" to complete the sentence. Thus, the active sentence "The boy hit the ball" when transformed as a passive

becomes "The ball was hit by the boy" using the following rule: det + N_1 + V + det + N_2 $\Rightarrow$ det + N_2 + <u>was</u> + V + <u>by</u> + det + N_1. A seemingly logical extension of this grammatical difference between actives and passives would suggest that since passive sentences contain more transformations, they should be somewhat more complicated and difficult to comprehend than active sentences. In fact, this is precisely the prediction made by a theory called the derivational theory of complexity.

A number of researchers in psycholinguistics have tested the validity of the derivational theory of complexity using active and passive sentences as part of their experimental stimuli. Mehler (1963) found that subjects in his experiment made significantly more errors when recalling passive sentences from a list than in recalling active sentences. Savin and Perchonock (1965) found that passive sentences took up significantly more space in short term memory than did the active sentences presented to subjects in their experiment. Gough (1965) simultaneously presented subjects with visual drawings and tape-recorded active or passive sentences for subjects to verify whether the drawings represented the same meaning expressed by the sentences. The time required for his subjects to comprehend and verify passive sentences was significantly greater than for active sentences.

From such experiments it is tempting to conclude that passive sentences are indeed more difficult to comprehend and remember than active sentences. Before drawing this conclusion, however, it is important to note that in the communication process one is not normally presented with a list of isolated, disconnected

sentences to remember, nor is one's comprehension time to respond normally measured with a stopwatch. Generally in the communication process listeners are asked to comprehend a message designed to evoke some more meaningful response or inference. Only a few studies have been done to compare the effects of syntactic transformations (e.g. active versus passive) on the comprehension of continuous discourse characteristic of that found in normal human messages.

Devito (1969) appeared to extend the findings of the previous research by showing that passive transformations complicate the comprehension of normal human messages. For his experiment, he prepared two versions of a message; one entirely written with active sentences and one entirely passive. After listening to one or the other of the forms of the message, subjects in his study were tested for comprehension by a cloze procedure test. Devito found that subjects who heard the active version performed significantly better than subjects hearing the passive version in filling in form class words on the cloze test. Passives thus appeared to be more difficult to comprehend than actives in this experiment.

One element missing in Devito's study was a control group to determine whether the poorer scores of the subjects in the passive condition were actually due to their difficulty in comprehending the message or whether the results were possibly an artifact of the passive cloze test being more difficult than the active cloze test. Tognetti and Shellen (1975) replicated the Devito study with the addition of the needed control groups to

get a measure of the clozentropy of the two versions of the test on subjects who did not hear the messages. They found that both experimental groups scored equally well over their control counterparts, thus concluding that the difference between active and passive conditions could be attributed to unequal difficulty of the tests, rather than unequal difficulty in comprehending the active versus passive messages.

Perhaps the most ingenious method of studying the role of transformations in comprehending continuous messages was developed by Sachs (1967). Following the presentation of brief recorded passages she questioned her subjects about one of the sentences heard in each passage. These test sentences were shown to the subjects in a form either identical to that originally heard in the passage or changed in meaning or syntactic form (actives were changed to passives or vice versa). She found that after only eighty syllables of discourse subjects could not recognize the changes in syntax although they readily identified any changes in meaning. She concluded that the syntactic form of a sentence is stored for only a short time in memory until comprehension of the meaning is complete. Considering the fact that humans are capable of comprehending messages at a rate much faster than normal speech rates, Sachs' study would suggest that comprehension of human messages should be relatively unaffected by the use of passive transformations rather than active transformations.

A corollary to Sachs' conclusion would suggest that if processing time when listening to connected discourse could be

constrained, it is possible that subjects would not have time to process the meaning from transformationally complex passive sentences as quickly as from their less complex transformational counterparts, the active sentences. In fact, temporal constraints in the form of immediate recall and response measures may explain why the earlier studies supported the derivational theory of complexity whereas those utilizing extended and connected discourse without artificial constraints on processing time did not support the theory.

The purpose of the present study is to test the effect of temporal constraints on the processing of active versus passive transformations in connected discourse. A direct test of the following hypothesis seeks resolution and explanation of the apparent conflict in the psycholinguistic literature regarding the derivational theory of complexity:

> H_1: Subjects listening to messages consisting of connected discourse will find passive transformations more complex than active transformations only when their time to process and comprehend the discourse is constrained.

Temporal constraint was defined for this study as a manipulation consisting of presenting the messages at highly compressed rates of speed.

METHOD

Two versions of a brief (five minute) experimental message were prepared. The message, "The Irreverent Adman" (McDougal, 1971) was chosen because it was written primarily with declarative sentences possessing a subject-predicate structure somewhat

easily rendered in either active or passive voice. The first version of the message was written using all active sentence structure which required little change from the original article. The second version of the message was transformed from the first into passive sentences. The transformations were basically accomplished by interchanging the subject and object and adding necessary function words (e.g. was, by) in each main sentence and in as many dependent clauses as possible. For example:

> Active version: "The adman bet his client that the ads would boost sales by 25% in six months. Mr. Paulucci took the bet."
>
> Passive version: "That the ads would boost sales 25% in six months was bet his client by the adman. The bet was taken by Mr. Paulucci."

The active and passive versions of the message were recorded on audio tape at monitored rates of approximately 150 words per minute. These "normal rate" recordings were then compressed by forty percent on a Fairbanks-type speech compressor, resulting in a presentation rate of approximately 250 words per minute. The forty percent compression rate was selected as the maximum time constraint on subjects' processing of the message yet still retaining intelligibility of the audio recording. Pilot work by McBride (1975) using a more conservative compression rate of thirty percent (215 wpm) found that slower rates were not sufficient to significantly reduce subjects' comprehension of the message when compared with the normal rate. Further pilot work by Shellen (unpublished) found that subjects' scores dropped below chance levels when they received the message compressed to fifty percent (300 wpm). The forty percent level

therefore hopefully represented a level intermediate between "too little" temporal constraint (30 percent) and "too much" temporal constraint (50 percent) established by the pilot research.

Two cloze procedure tests were constructed, one for each version of the experimental message. Cloze procedure was selected as the dependent measure of comprehension in order to assess subjects' recall at a syntactic as well as semantic level. As Weaver (1972; 141) points out, cloze procedure taps variables related to "knowledge of the deep structure of the language and the predictability of form-class and function words, arising partly from the structure of the language and partly from semantic implications."

The cloze tests sampled only the last 300 words at the end of each version rather than the entire message because the addition of function words in the passive message resulted in it being slightly longer than the active version. Further, pilot study determined that it took longer than the allotted time to administer a cloze test over the entire message and the task was too fatiguing to the subjects. A deletion scheme starting at random and then deleting every fifth word (Osgood, 1959) resulted in a 60 item cloze test for each version of the message. The active version of the cloze test contained 41 form-class items (nouns, verbs, adjectives, etc.) and the passive version contained 32 form-class items out of the total of 60 items per test. Exact word (or same root word) answers by subjects were scored as correct answers. Synonyms were not counted as correct in order to minimize subjectivity in the scoring of the tests.

One hundred and eight volunteer university student subjects were randomly assigned to the six cells of a 3 x 2 completely randomized factorial design. One third of the subjects were in a control condition and completed either the active or passive version of the cloze test without hearing any message. The next third of the subjects heard either the active or passive version of the message presented at the normal (uncompressed) rate and then completed the appropriate version of the cloze test. The final third of the subjects heard either the active or passive version of the message presented at the compressed rate and then completed the cloze test.

RESULTS

Because the cloze tests contained unequal ratios of form-class to function word items in the active versus the passive versions of the test, it was determined to conduct the analysis using only the form-class items on the cloze tests as the dependent measure. Since the two test versions had unequal numbers of form-class items, scores were converted to proportions (total correct/total possible) to equalize the metrics of the tests. Prior to the analysis of variance, arcsin transformations were applied to the proportions after the method described by Kirk (1968). The design format and mean proportion of correct form-class fill-ins are illustrated in Table 1.

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Insert Table 1 about here

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The analysis of variance, presented in Table 2, showed that the interaction was not significant. This finding is the most important since the major hypothesis for the study predicted an interaction in which passive transformations would be found more difficult to comprehend than active transformations only for subjects listening to the message under the temporal constraint of compressed speech. Thus, the null hypothesis corresponding to the major hypothesis of this study was not rejected.

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Insert Table 2 about here

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There was a significant main effect between active versus passive transformations. However, the reader is cautioned not to interpret this effect as evidence of superior comprehension of active versus passive language in the messages. An inspection of Table 1 shows that the difference between active and passive transformations was true for all groups including the control groups who heard no messages. Thus, the active versus passive main effect is best interpreted as evidence that the two versions of the cloze test, active versus passive, were of unequal difficulty even after the scores were converted to proportions. The entire purpose of the control group was to allow for an unambiguous interpretation of the main effects such as the above.

There was also a significant main effect attributable to the three message constraint conditions (control-no message vs.

normal rates vs. compressed rates). Scheffé contrasts were used to compare the means of the three groups. Subjects hearing the messages at normal rates significantly outscored the control subjects ($F = 36.11$; $p < .05$) and also outscored the subjects hearing the messages at compressed rates ($F = 21.93$; $p. < .05$). Subjects hearing the messages at compressed rates did not differ significantly from control subjects who took the tests without hearing the messages ($F = 1.76$; N.S.).

The last finding, that subjects listening to compressed messages did not score higher than control subjects, was particularly disappointing. This finding suggested that the forty percent compression rate (250 wpm) put too great a constraint on the processing time needed by subjects to comprehend the messages. Therefore, the interaction hypothesis for the study may not have had a fair test since it would not matter whether the speaker on the recordings were speaking in active or passive sentence structures if the subjects could not understand the compressed messages at all. However, for at least two reasons, it does not seem likely that the major interaction hypothesis under investigation in this study would stand any better chance of support by replication of the study using more moderate compression rates. First, previous research has shown that only slightly lower compression rates than those used in the present study (30 percent versus 40 percent) did not constrain subjects processing of the messages enough to allow for a test of the interaction (McBride, 1975). Secondly, the trends of the present data, though nonsignificant, were in exactly the opposite direction of the predicted

interaction; i.e. the temporal constraint of compression negatively affected subjects' comprehension of the active version of the message slightly more than the passive version.

DISCUSSION

The rationale for this study was conceptualized nearly three years ago and was carried through seven separate preliminary data-gathering efforts leading to the present nonsignificant finding. The original purpose was to determine whether human comprehension of connected discourse characteristic of normal communicative messages had any parallel to the research and models established by a decade of psycholinguistic studies of sentence perception. Psycholinguistic research into the derivational theory of complexity revealed that linguistic descriptions of transformational complexity could be used successfully to predict human comprehension performance under certain select conditions; i.e. the linguistic stimuli consisted of isolated, disconnected sentences and the subjects' response times were constrained. The present study, by artificially constraining subjects' processing time while listening to connected discourse sought to find the same effects based on linguistic derivational complexity models as had been found in earlier psycholinguistic studies of sentences. The present results, however, do not support such a simplistic view of the human processing of connected discourse.

Even under severe temporal constraint on processing, human comprehension cannot apparently be conceived as a series of

grammatical computations operating on the linguistic structures of a message. A number of psycholinguists have abandoned such purely linguistic models even when describing human sentence processing (Fodor, Bever & Garrett, 1974).

In reviewing the literature, the only study found in which the derivational theory of complexity was successful in predicting human processing of connected discourse was the study by Devito (1969). The present study provides direct replicative support for the earlier findings of Tognetti & Shellen (1975) who demonstrated that the difference between cloze scores of subjects listening to active versus passive messages is probably attributable to unequal difficulty of the versions of the cloze tests, rather than unequal difficulty in comprehending the messages. Thus, no unequivocal studies were found in which linguistic theory predicted human message processing.

The future direction for research in human processing of messages may be concerned far more with the influence of context, both linguistic and nonlinguistic, and an increasing concern for what is said or understood in a message (semantics) rather than how it is said (syntax). Even the selection of cloze procedure as a dependent variable for the present study represented undue concern for exact retrieval of words and syntactic information, which is not typical of the response expected from people in everyday communication. Further researchers need to heed the criticism of Carswell & Rommetveit (1971; 4) who point out that "the psycholinguistic movement has followed linguistic advances very closely and has more often dealt with the problem of

correlating psychological processes with logical linguistic structures than with language as a communication process."

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Table 1

Mean proportions of correct form-class responses on the cloze procedure test for each experimental group.

Message Constraint Condition	Active Transformations	Passive Transformations	Row Means
Control (No message)	.310	.178	.245
Normal Rate (150 wpm)	.440	.328	.384
Compressed Rate (250 wpm)	.309	.240	.274
Column means	.353	.249	

Table 2

Analysis of variance of form-class cloze score proportions (with arcsin transformation).

Source	SS	df	MS	F
Message Constraints	.498	2	.242	19.934*
Active vs. Passive	.390	1	.390	32.123*
Interaction	.027	2	.013	1.099
Within	1.238	102	.012	
Total	2.139	107		

*$p < .05$